

Spotlight on PAR38s



Lightfair 2014

June 4, 2014

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CALiPER Series 20: PAR38 Lamps

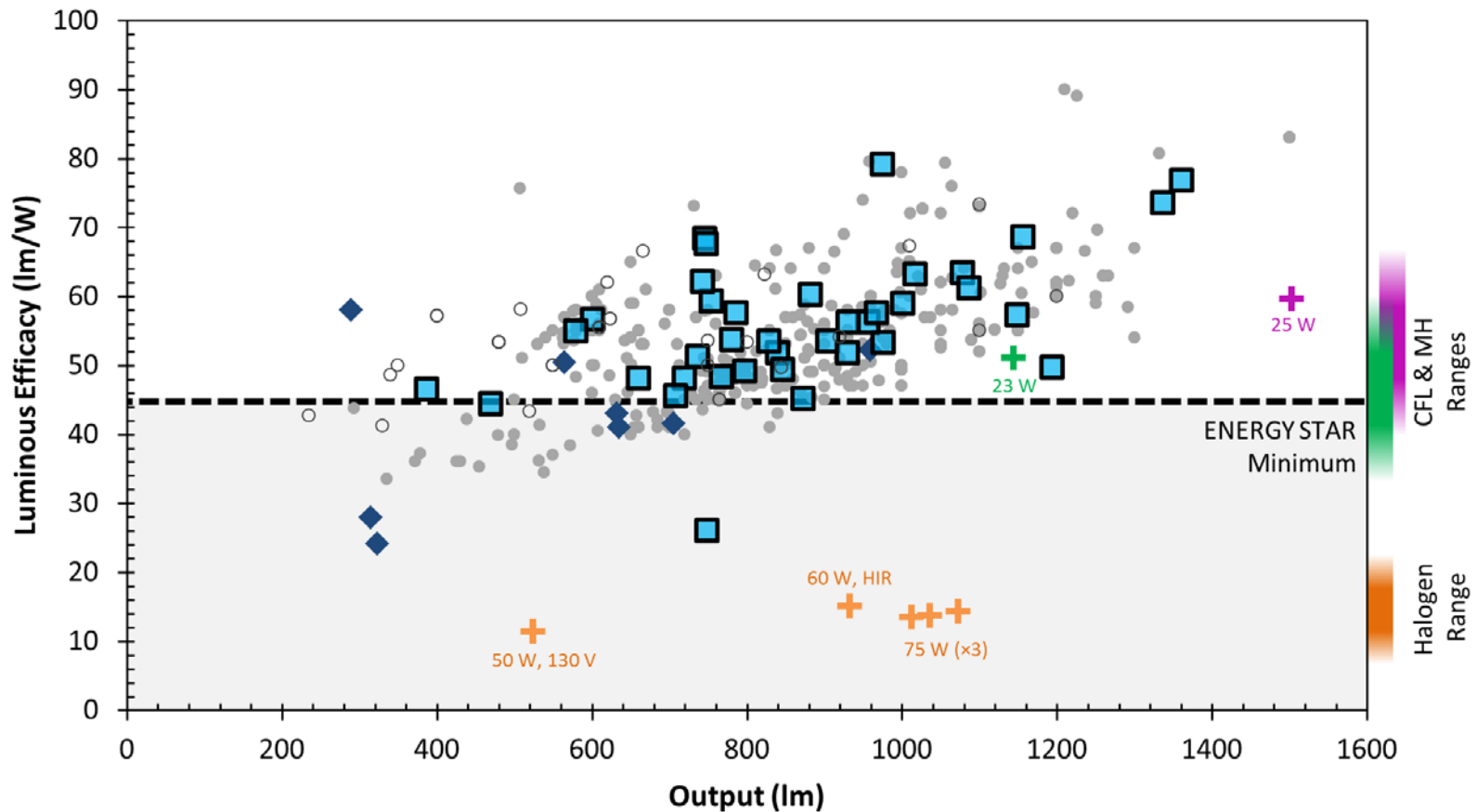
- **Application Report 20**
 - 38 LED PAR38 lamps + 5 benchmarks underwent photometric testing
 - Basic performance comparisons and evaluation of manufacturer claims
 - Do LED PAR38s outperform benchmarks?
- **Report 20.1 – Subjective Evaluation**
 - 26 LED and halogen PAR38 lamps installed for a demonstration event
 - Feedback collected on beam quality, shadow quality, and color quality
 - When going beyond numerical metrics, do LED PAR38s outperform halogen lamps?
- **Report 20.2 – Dimming, Flicker and Power Quality**
 - Flicker and power quality performance of the Series 20 lamps at full output and various dimmed levels
 - Measurements of luminous flux, flicker, and power quality were taken at 10 target dimmed settings and compared with operation on a switch
- **Upcoming CALiPER Reports on PAR38s**
 - 20.3: Stress Testing
 - 20.4: Long-term Testing

LED PAR38 Lamps



Reports available on
www.ssl.energy.gov
under CALiPER

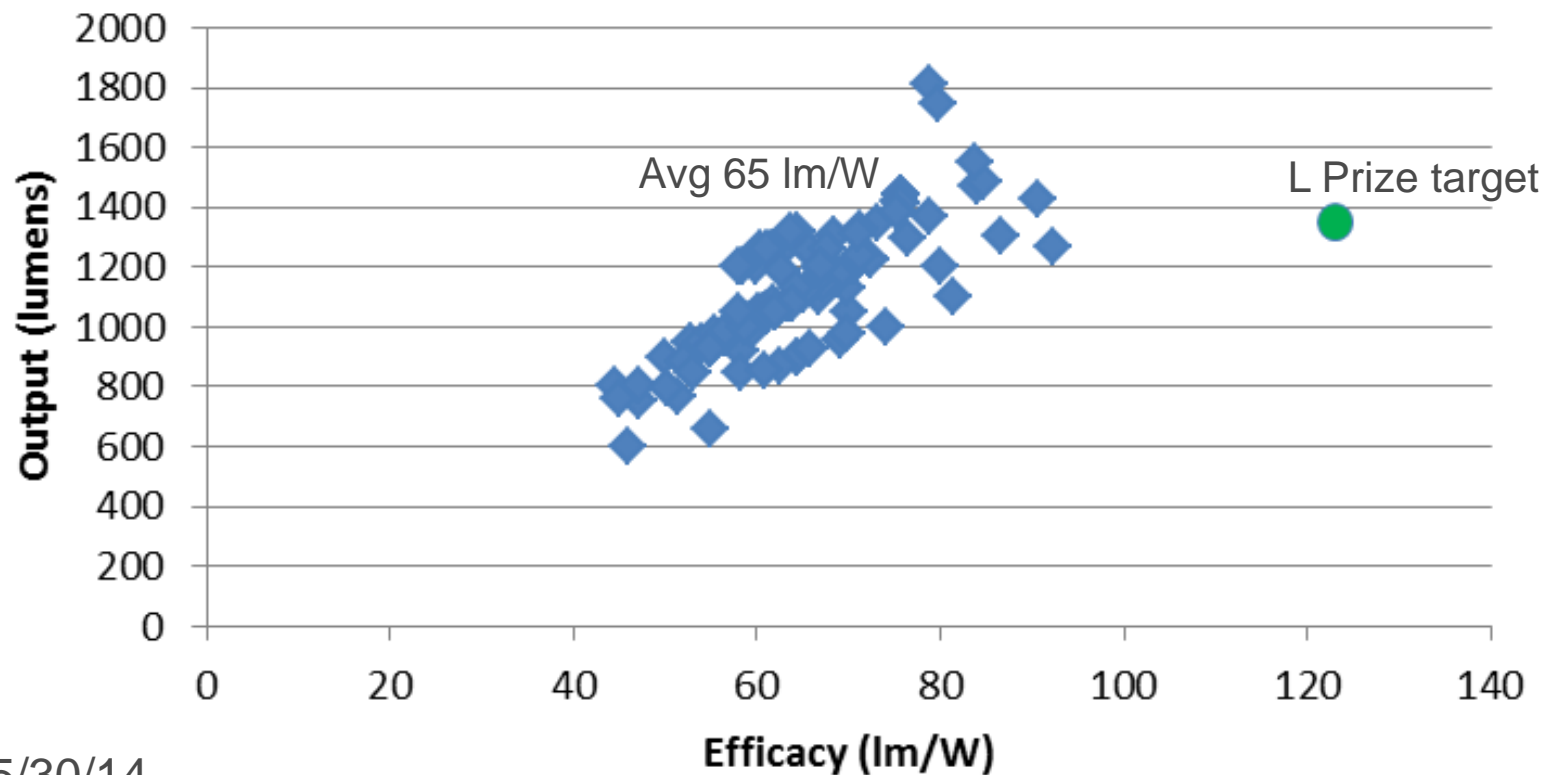
Output and Efficacy of Tested PAR38 Lamps



- Series 20 LED PAR38 Lamps (2012)
- ◆ Previously Tested LED PAR38 Lamps (2008–2010)
- LED Lighting Facts Data (October 2012)
- ENERGY STAR Data for Qualified LED Products (October 2012)
- ✚ Halogen Benchmarks
- ✚ CFL Benchmark
- ✚ CMH Benchmark

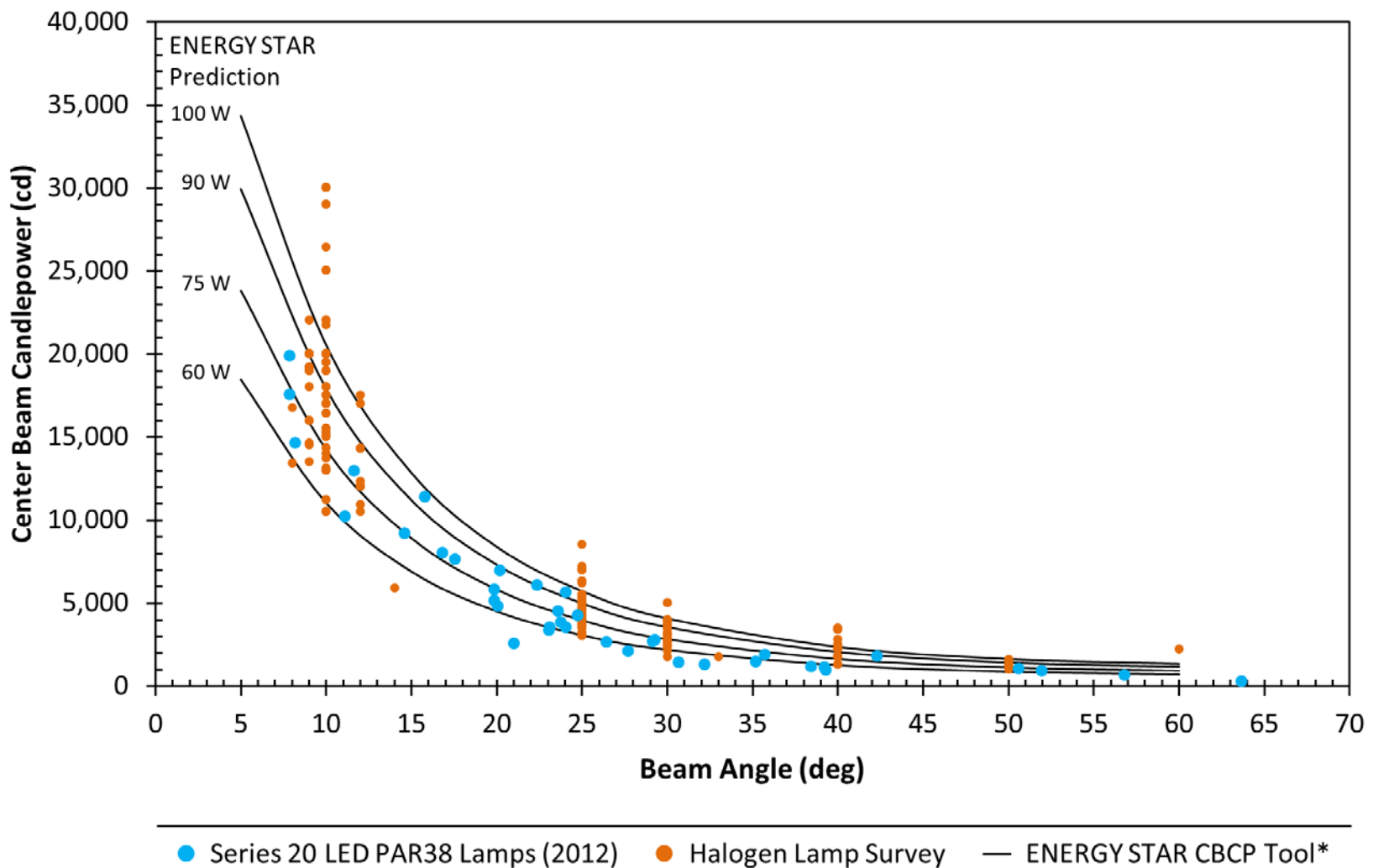
Current Performance

Output and Efficacy of LED Lighting Facts Listed PAR38 Lamps



5/30/14

Center Beam Intensity of Tested PAR38 Lamps



* Predicted value, not minimum value.

CALiPER Report 20.1: Subjective Evaluation

- Demonstration event including 20 LED PAR38s and 6 halogen PAR38s
- 20 Members of the local IES chapter visited to provide feedback on difficult-to-quantify performance aspects
 - Beam quality
 - Shadow quality
 - Color quality
- Lamps divided into four groups
 - Spot
 - Narrow flood (also used for evaluation of shadow)
 - Flood
 - Color
- Wireless control system allowed for group and singular viewing

20.1: LED PAR38 Subjective Evaluation

Beam Quality

- Three groups
 - Spot
 - Narrow Flood
 - Flood
- Aimed at white wall

Shadow Quality

- One group
 - Narrow Flood
- Aimed at synthetic flower in glass vase, about 1' in front of wall

Color Quality

- One Group
 - Color
- Aimed at color sample board including Color Checker, fabric, & paint samples

20.1: LED PAR38 Subjective Evaluation

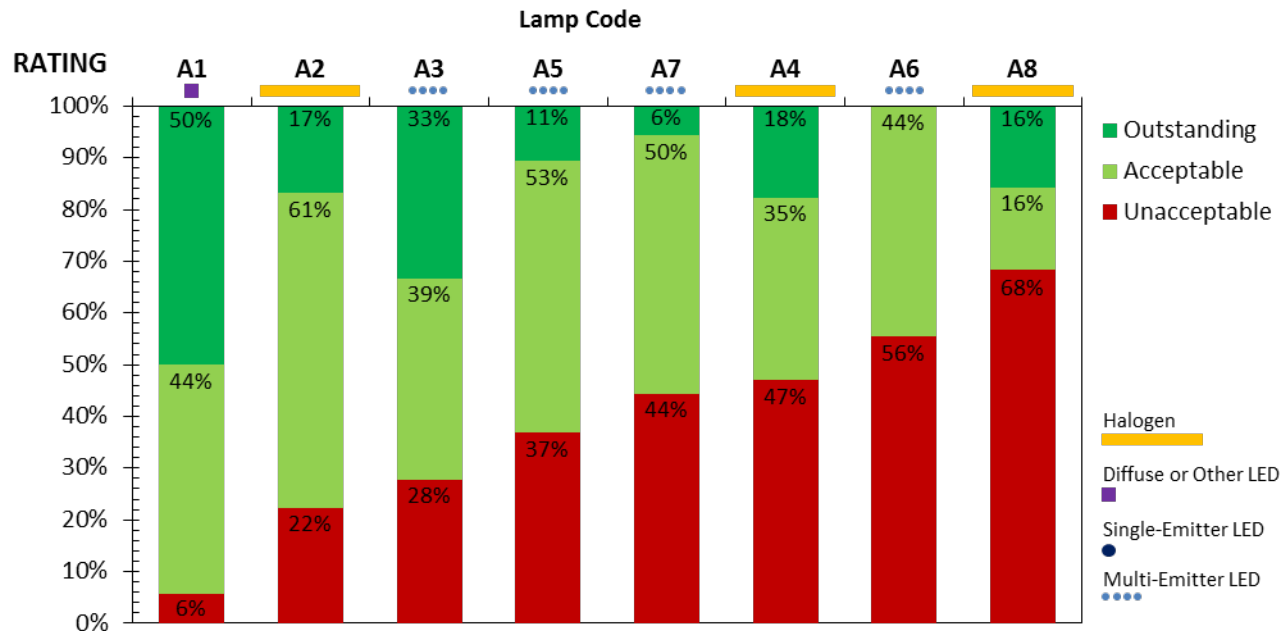


LED PAR38 Evaluation Event

- 26 lamps installed
 - 8 spots rated 8-17° beam only
 - 6 narrow floods rated 25-30° color only
 - 6 narrow floods rated 25° beam & shadow
 - 6 floods rated 40-55° beam only
- 21 people attended
 - Local IES chapter
- Questionnaires completed

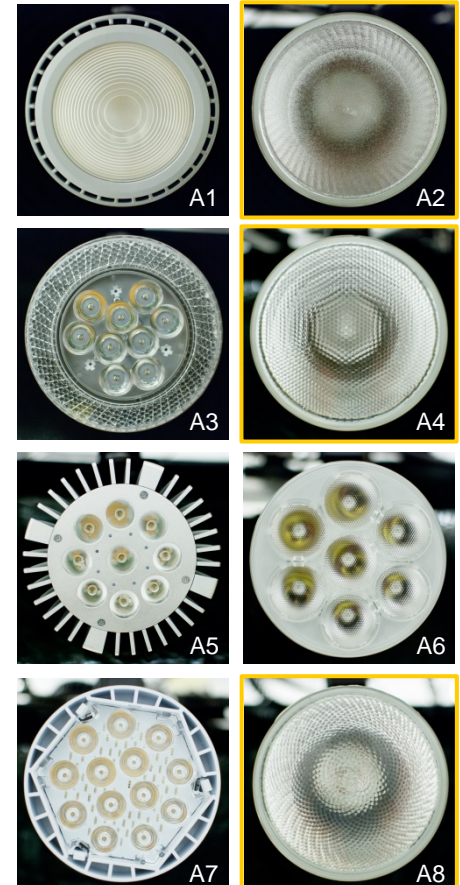


LED PAR38 Beam Quality: Spot Results



RANKING

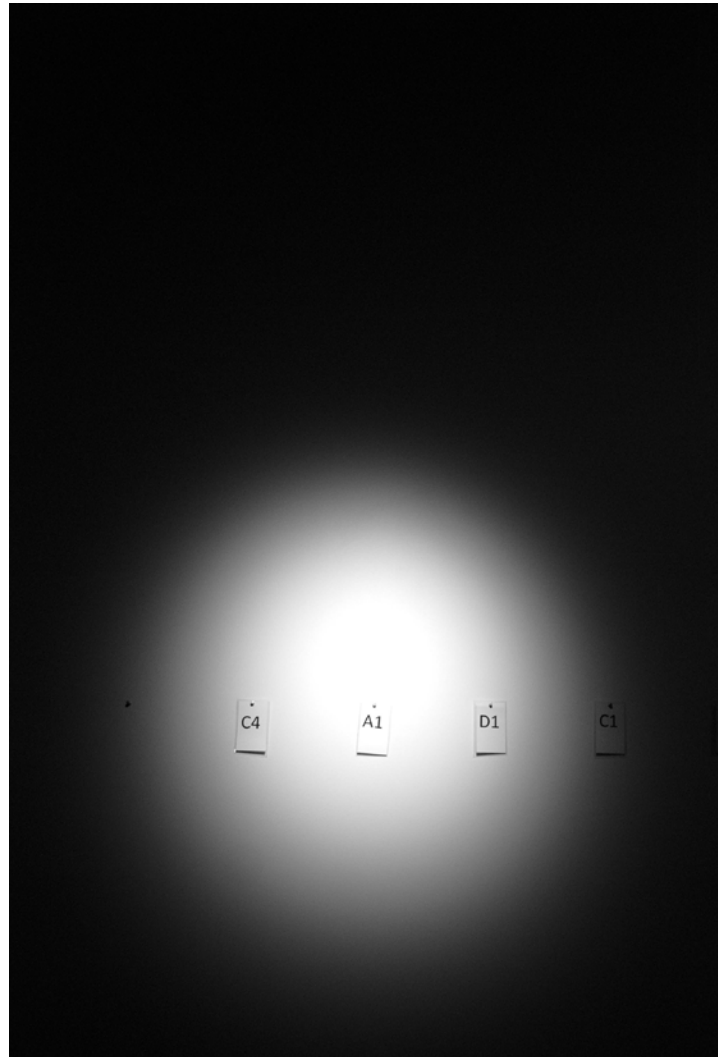
Mean	2.5	4.2	3.1	4.4	4.9	4.5	5.6	6.7
Mode	1	3	1	5	3	4	8	8
Min	1	2	1	1	2	1	2	3
Max	8	7	7	7	8	7	8	8



Beam Quality Examples: The Good, Bad, & Ugly

A1

Best rated / highest
ranked LED in Spot
group



Favorable (10+):

- Beam Edge
- Falloff/Gradient

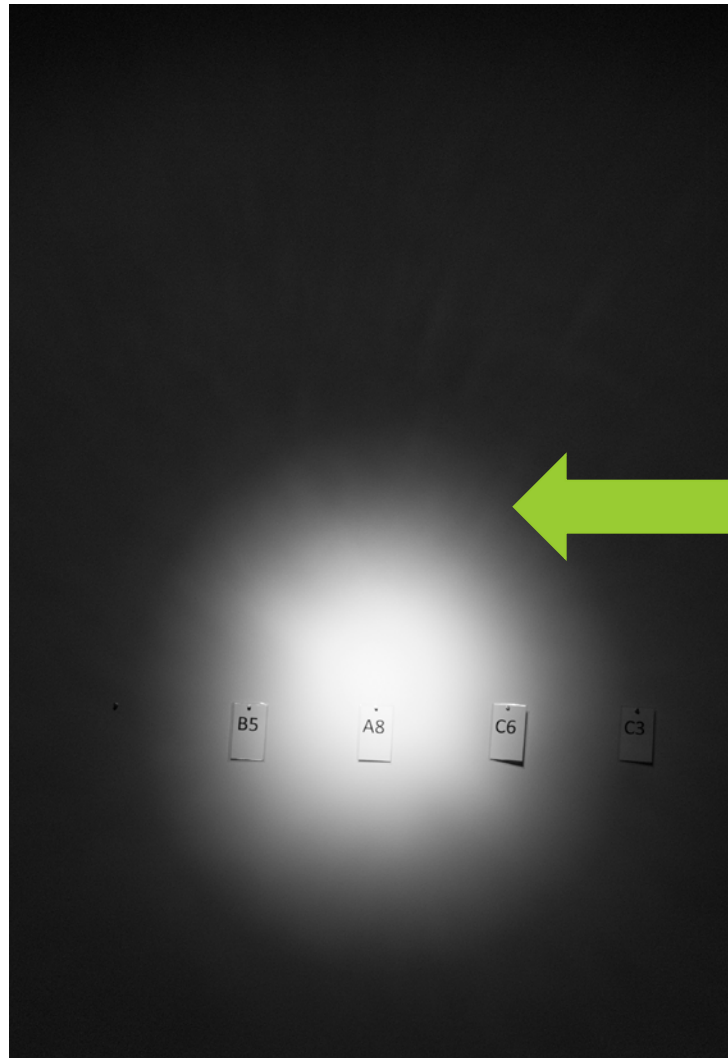
Unfavorable (10+):

Photographs can be deceiving!

Beam Quality Examples: The Good, Bad, & Ugly

A8 (Halogen)

Worst rated / lowest ranked in Spot group



Radial striations

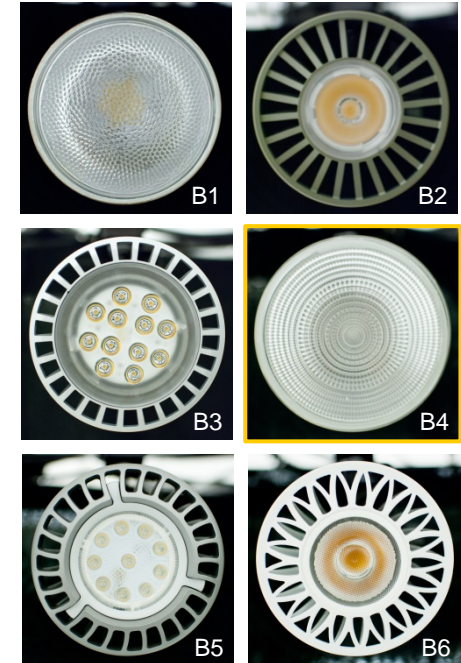
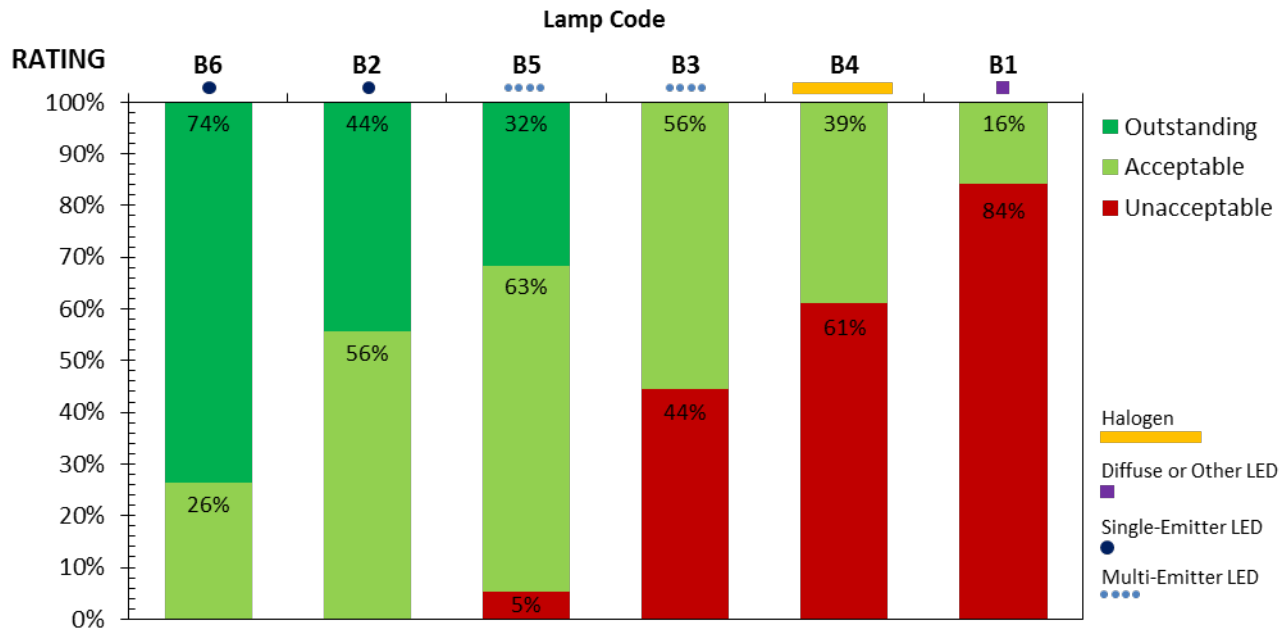
Favorable (10+):

Unfavorable (10+):

- Stray Light

Photographs can be deceiving!

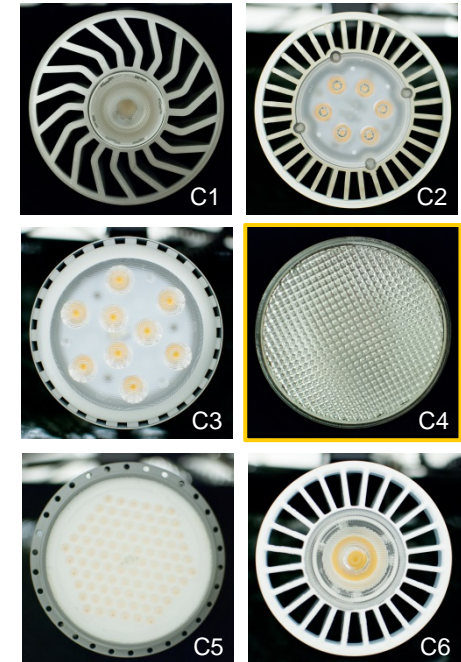
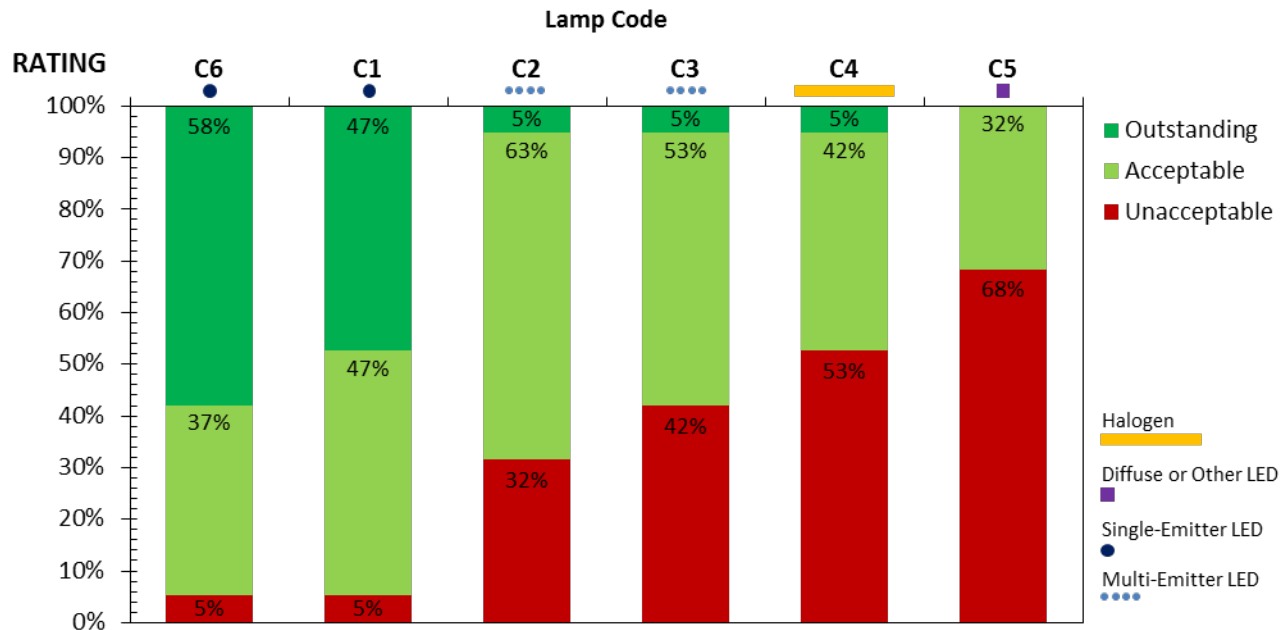
LED PAR38 Beam Quality: Narrow Flood Results



RANKING

	B6	B2	B5	B3	B4	B1
Mean	1.4	1.7	3.1	4.5	4.8	5.7
Mode	1	2	3	4	5	6
Min	1	1	2	3	4	4
Max	2	3	5	6	6	6

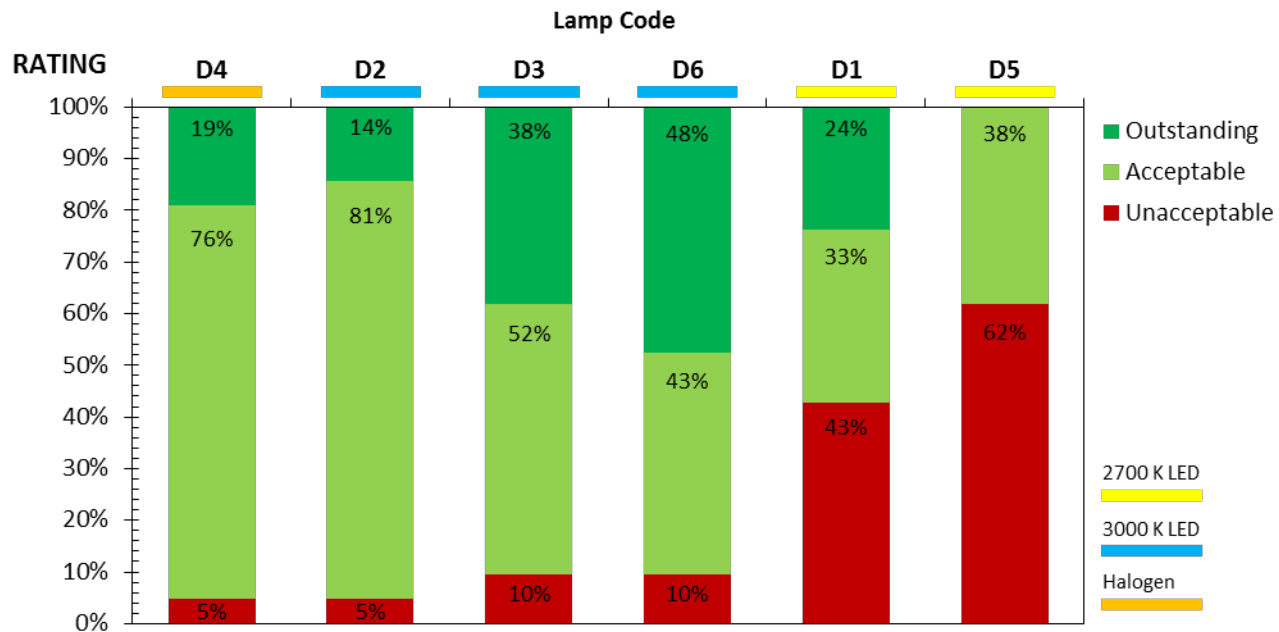
LED PAR38 Beam Quality: Flood Results



RANKING

	C6	C1	C2	C3	C4	C5
Mean	1.8	2.1	3.8	3.8	4.5	5.1
Mode	1	2	5	4	6	6
Min	1	1	1	2	1	3
Max	6	5	5	6	6	6

LED PAR38 Color Quality Results

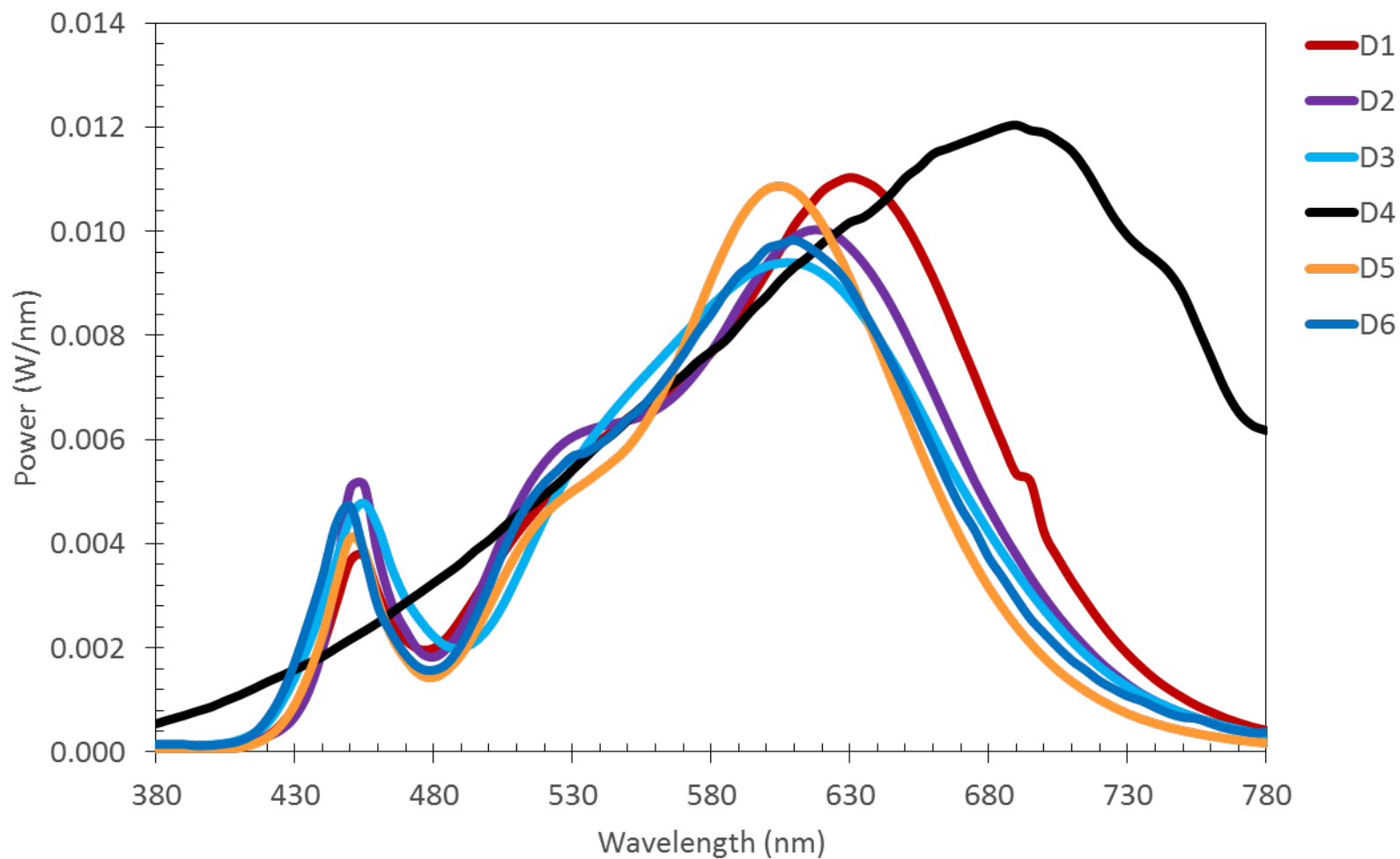


RANKING

Mean	2.9	3.5	2.7	2.7	4.1	5.3
Mode	2	4	1	1	5	6
Min	1	1	1	1	1	3
Max	5	6	5	6	6	6

CRI: 100 93 83 86 96 82

Color Quality Results



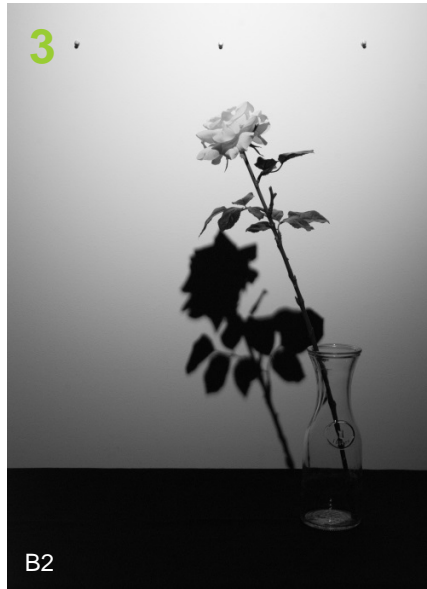
Shadow Quality Results

Rank:

2



3



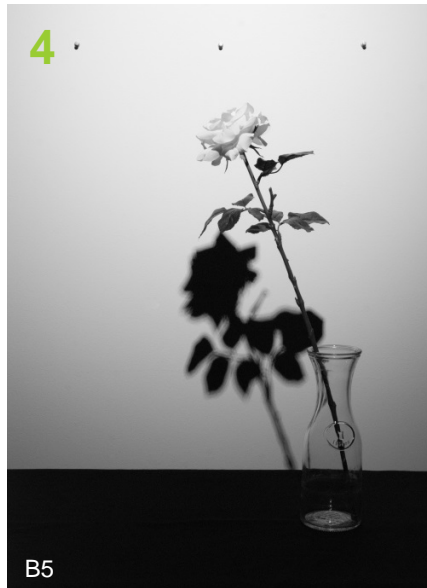
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6



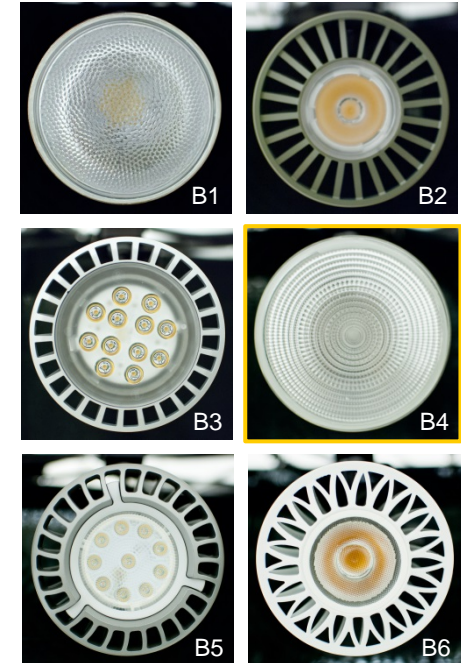
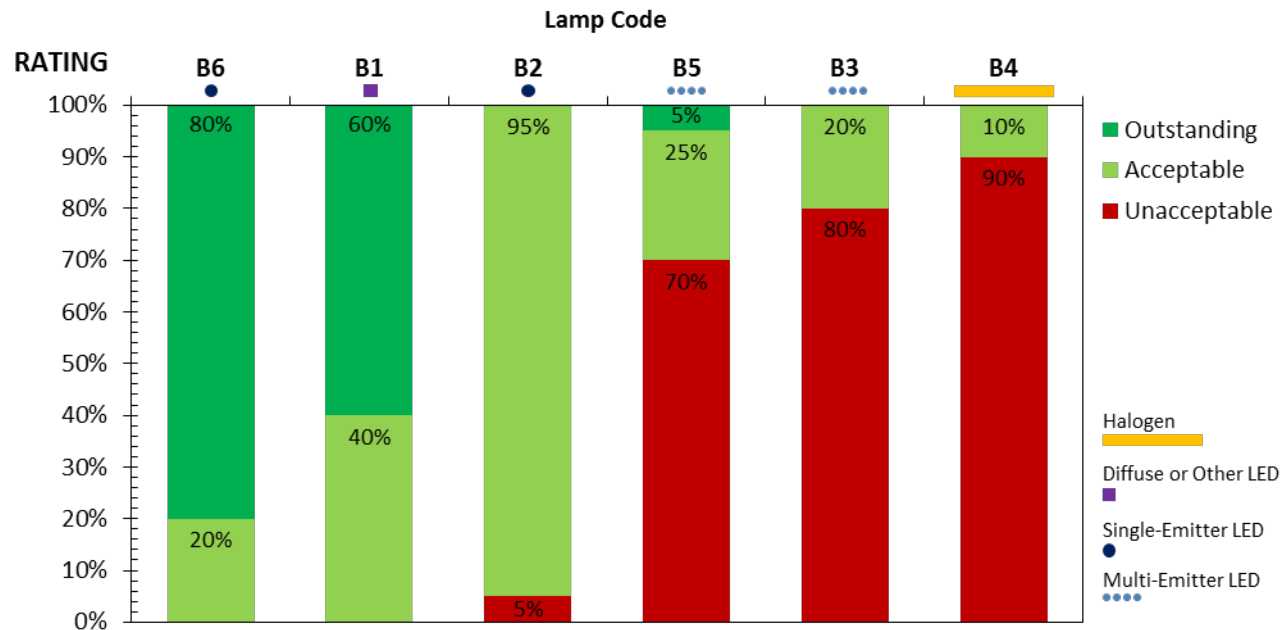
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1



Shadow Quality Results



RANKING

Mean	1.4	1.7	3.1	4.5	4.8	5.7
Mode	1	2	3	4	5	6
Min	1	1	2	3	4	4
Max	2	3	5	6	6	6

CALiPER Report 20.1 Conclusions

- In each category, at least one LED lamp was rated more favorably than the benchmark halogen. Halogen should not always be considered the ideal source for lighting quality.
- Single-emitter LED lamps were favored in both beam quality and shadow quality
- Poor color consistency within the beam, and stray light outside the main beam pattern, were the attributes most likely to be noted by the observers as negatives
- LED lamps with narrow spot distributions were generally viewed as having less-acceptable beam quality than their narrow-flood or flood counterparts
- Observers generally preferred 3000 K LED lamps over 2700 K LED lamps, but their ranking of color quality did not always correlate with the CRI of the lamps

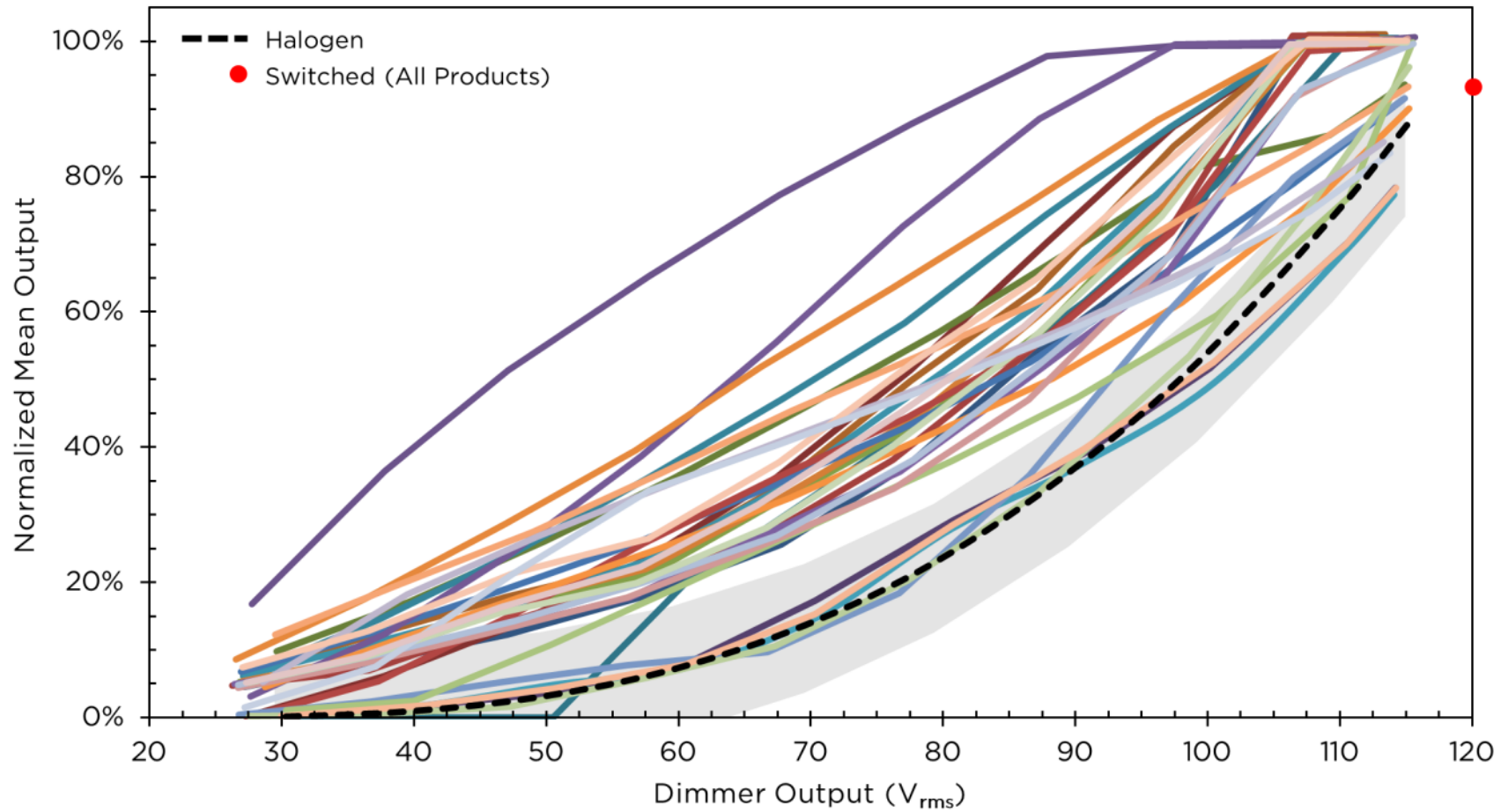
Full report available at:

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_20.1_par38.pdf

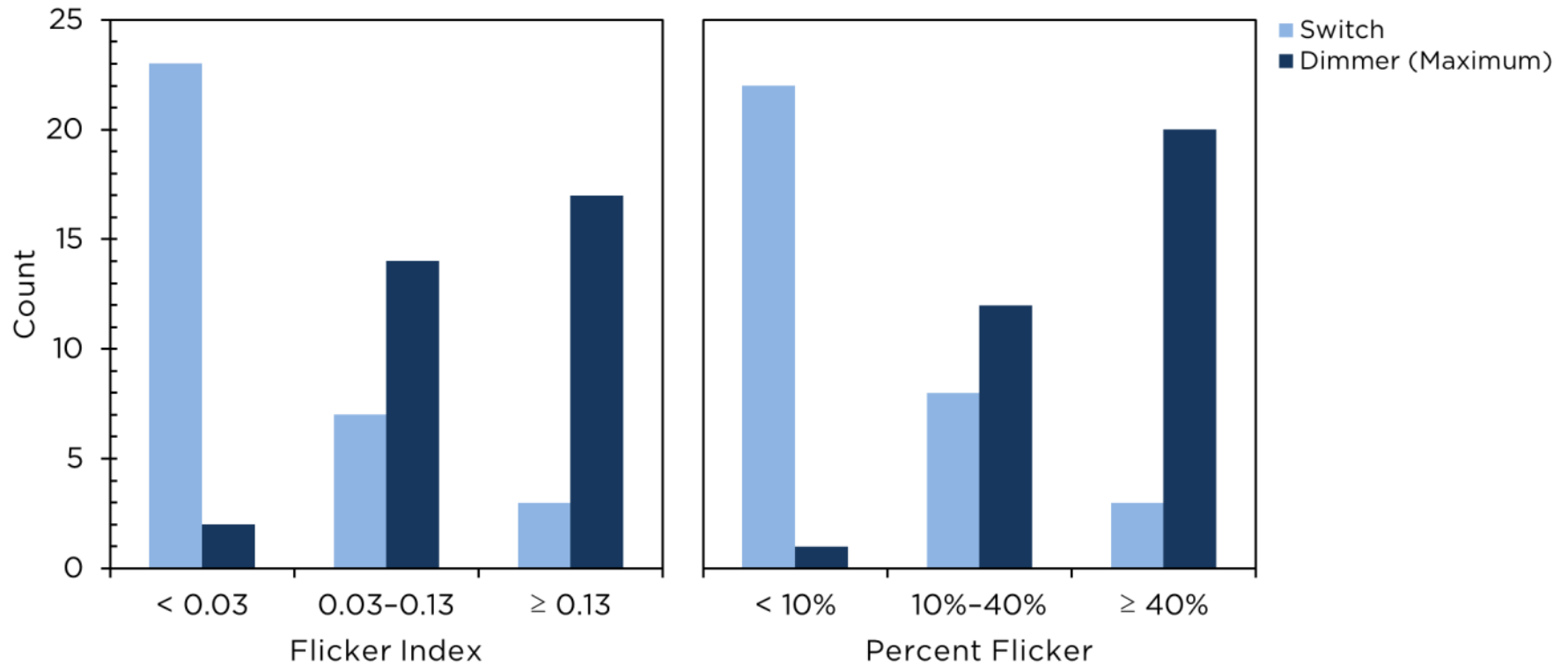
Report 20.2: Dimming, Flicker, Power Quality

- Tested all series 20 PAR38s that claimed dimmability
- Benchmark halogen lamps also tested
- One phase cut dimmer: Leviton SureSlide Decora 6674
- Tested at 10 pre-determined target voltages

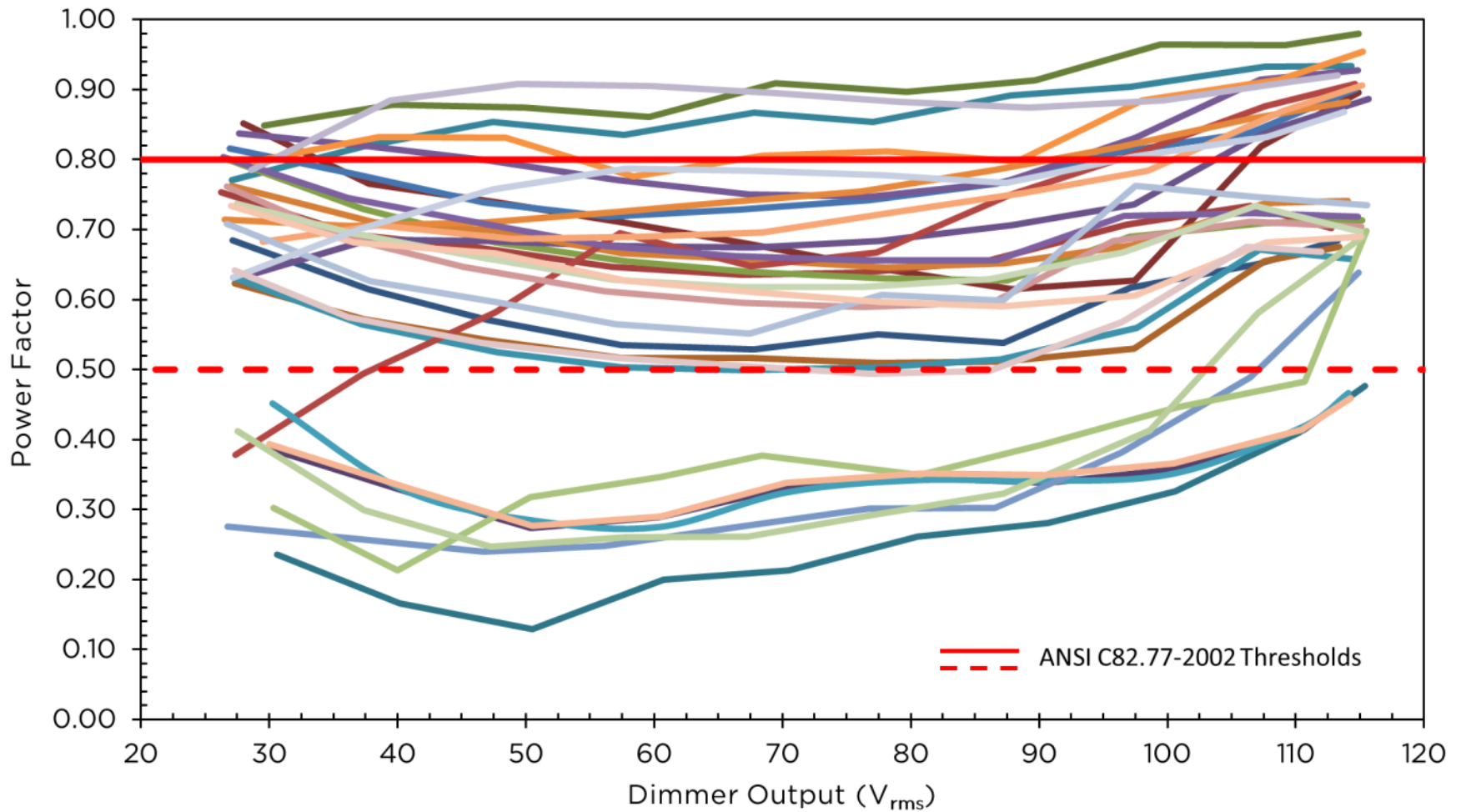
PAR38 Dimming



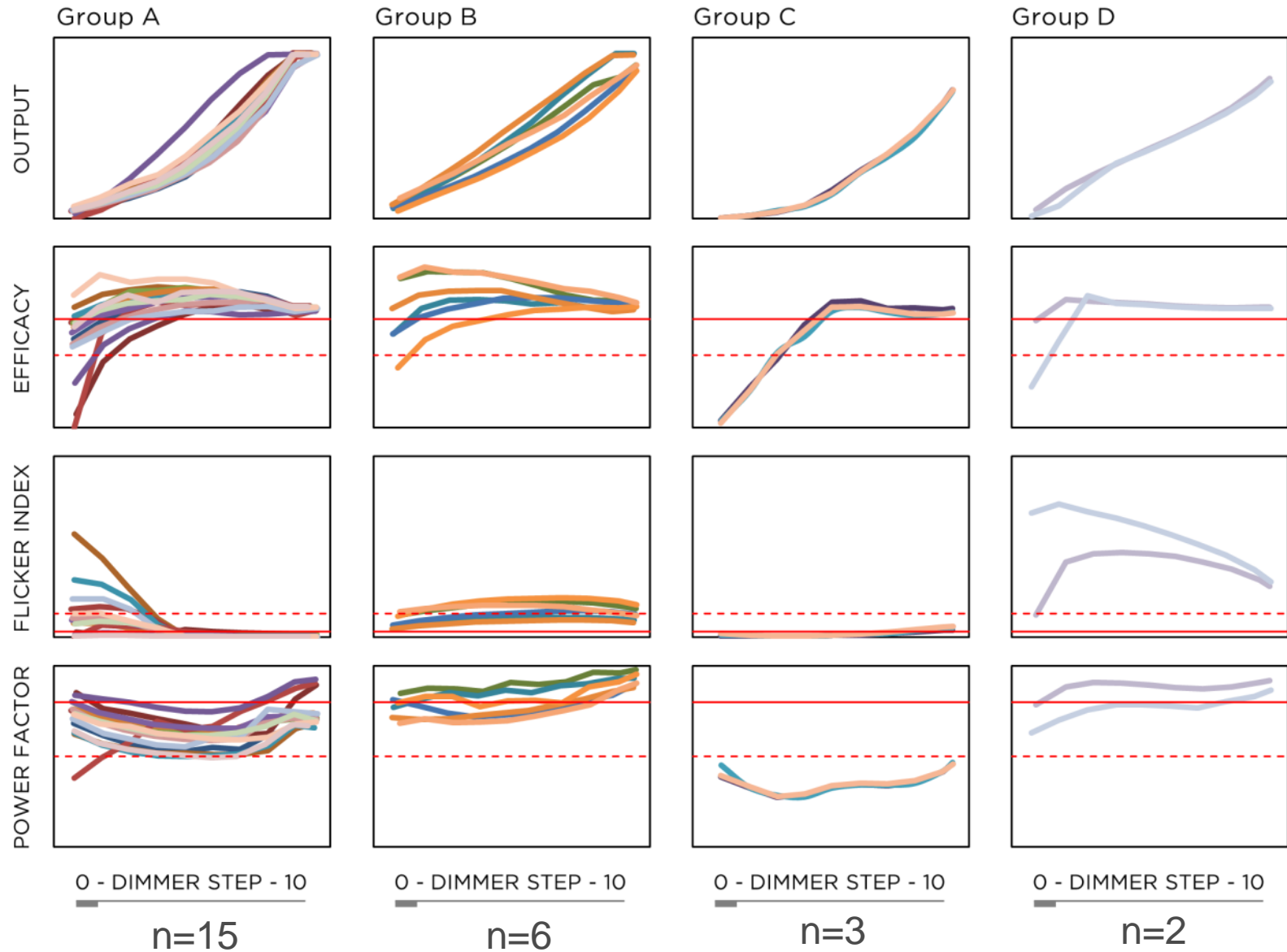
PAR38 Dimming and Flicker



PAR38 Dimming and Power Quality



PAR38 Performance Groupings



20.2 Conclusions

- Most LED lamps produced more relative light output at a given dimmer level than the benchmark halogen PAR38 lamps.
- The most frequent dimming characteristic that is not present for halogen lamps was high end dead travel, although this typically occurred over only a small range. Additional testing with finer voltage steps may be warranted.
- When operated by a switch, almost all of the LED PAR38 lamps tested exhibited less flicker than a magnetically ballasted fluorescent lamp, and more than two-thirds exhibited less than or comparable flicker to a halogen lamp. However, when dimmed, both Flicker Index and Percent Flicker indicate that about half of the lamps exhibited more flicker than a magnetically ballasted fluorescent lamp, and almost all of the LED products exhibited more flicker than a typical halogen lamp.
- While all of the LED lamps tested met the current ANSI-defined thresholds for power factor (power less than 35 W) when operated by the switch, nearly one-third had a power factor of less than 0.5 at some point over the dimming range, which would not meet the standard.

Questions?

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